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SUBJECT—

TITLE

A REVIEW OF INSECT CONTROL IN THE ARROWHEAD-CRESTLINE INFESTATION AREA 1921 - 1953

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A Review of Insect Control in the Arrowhead-Crestline Infestation Area

1921 - 1953

SUMMARY

Insect control work has been carried out in the Arrowhead-Crestline infestation area since 1921. Most of this work was directed against western pine beetle infestations in the area. From 1921 to 1940, the work was conducted on a sporadic basis. The problem received a great deal of attention when losses were high, but was practically forgotten during periods of light losses. In 1940, a cooperative maintenance control program was initiated by the U. S. Forest Service, the State Division of Forestry, and private land owners in the area, and since that time, annual maintenance control projects have been conducted.

In 1947, western pine beetle losses started to increase. Up to 1949, this increase occurred gradually and the control program was stepped up accordingly. However, during the summer of 1949, beetle populations pyramided rapidly and by the following winter reached epidemic proportions. The maintenance control program was not geared to handle this rapid, unexpected increase and the infestation got entirely out of hand. As a result, one of the worst epidemics ever experienced in this area has been raging for the last three years. During this period, a tremendous number of very valuable trees have been killed and, even if the epidemic is checked in the immediate future, the area will have suffered greatly from the damage that has been done.

It is extremely important that the emergency action now being taken to check the heavy losses that are occurring is supplemented by other measures if this area is to be provided protection commensurate with the values at stake.

Recommended action includes:

1. The formation of a work committee to establish objectives in the protection program and to decide on control policies and action.

2. Provision for constant surveillance of insect conditions within the infestation area.

3. Initiation of a more intensive and more flexible direct control program than that being followed at present.

4. An intense and continuous public education program.

5. Abatement of hazards created by fire or natural forces.

6. Indirect control through silvicultural measures where applicable.

7. Placing appropriate emphasis on research needs.

INTRODUCTION

The Arrowhead-Crestline infestation area is located in the northwest corner of the San Bernardino Mountain Range in Southern California. It is a very heavily used recreational forest area comprised of both federal and private land (see attached map).

Size - Forest lands within the infestation area total approximately 40,000 acres.

Use - Recreational use and developments are as follows:

	Private Land	Federal Land
Number of annual visitors	2,000,000	885,000
Summer homes and yearlong residences	8,000	685
Hotels, resorts and camps	84	28

The attached land use map shows the principal type of recreational use throughout the area.

Principal tree species

Predominant	Ponderosa pine Coulter pine Jeffrey pine
Secondary	Sugar pine White fir Oaks (black and live) Some Incense-cedar; also Bigcone-spruce in the steep canyons

Stand composition - For entomological consideration, the area can be divided into two general pine types; (1) the Coulter-ponderosa pine type, and (2) the Jeffrey pine type.

Coulter and ponderosa pine stands make up over 80 percent of the pine forests within the infestation area. This general type starts at the western boundary of the infestation area and extends east through Miller Canyon, Crestline, Lake Arrowhead and Running Springs (see attached map). The Jeffrey pine type starts east and north of Arrow Bear Lake and extends to the eastern boundary of the infestation area.

Most of the Coulter-ponderosa pine area is composed of cutover lands. In general, the forest cover consists of dense, pole sized stands of Coulter and, or, ponderosa pine in pure stands or mixed with sugar pine, white fir, and cedar. Mature and overmature ponderosa pines are scattered, in small groups or individually, throughout the area. The principal forest cover

within the Jeffrey pine type consists mainly of mature and overmature Jeffrey pine, often with a dense understory of Jeffrey pine reproduction.

Principal forest insects

Insect	Host
Western pine beetle (Dendroctonus brevicomis Lec.)	Ponderosa pine Coulter pine
Mountain pine beetle (D. monticolae Hopk.)	Sugar pine Ponderosa pine
Jeffrey pine beetle (D. jeffreyi Hopk.)	Jeffrey pine
Red turpentine beetle (D. valens)	Jeffrey pine Ponderosa pine
California flatheaded borer (Melanophila californica Van D.)	Jeffrey pine Ponderosa pine
California five-spined engraver beetle (Ips confusus (Lec.))	Ponderosa pine Coulter pine
Fir engraver beetle (Scolytus ventralis Lec.)	White fir
Black pine leaf scale (Nuculaspis californica (Coleman))	Ponderosa pine
Fruit tree leaf roller (Archips argyrospila (Walker))	Live oak (principal forest tree host)

The western pine beetle and the California five-spined engraver beetle are by far the most important forest insects currently active in the area. These insects have taken a heavy toll of ponderosa and Coulter pine during the last three years. The fir engraver beetle and the mountain pine beetle are not as important as the two species mentioned above only because their principal host trees (white fir and sugar pine respectively) do not comprise a very high percentage of the timber stand. However, both of these insects have caused relatively heavy losses wherever their host trees occur.

The Jeffrey pine beetle has been responsible for high endemic losses in Jeffrey pine at various times, but has not been aggressive enough to warrant intensive control action. The red turpentine beetle and the California flatheaded borer are, in most cases, associated with the western pine beetle and the Jeffrey pine beetle, and have not been of a great deal of importance by themselves.

The black pine leaf scale and the fruit tree leaf roller are of local importance in the Crestline area. The black pine leaf scale has been active in and around the town of Crestline for over ten years. A large number of trees in this valuable recreation area are heavily infested with this scale and

each year some of these trees die. The infestation has apparently become progressively worse each year, and it is doubtful that it will subside unless positive control action is taken. The fruit tree leaf roller did not become a problem until the spring of 1952, when heavy defoliation of live oaks occurred in the Crestline area. The potentialities of this outbreak are not known. Little or no tree mortality is expected from this or subsequent defoliations; however, the 1952 outbreak caused a great deal of public alarm and any further damage may instigate demands for action, as aesthetic values are impaired by the damage.

HISTORY OF CONTROL IN THE ARROWHEAD-CRESTLINE INFESTATION AREA

Control efforts in the Arrowhead-Crestline area have been primarily directed against the western pine beetle and the California five-spined engraver. Ponderosa and sugar pine infested with the mountain pine beetle and Jeffrey pine infested with the Jeffrey pine beetle were treated whenever they were encountered within the control boundaries. No control has been carried out against the fir engraver beetle, the California flatheaded borer, the fruit tree leaf roller, or the black pine leaf scale (except on an experimental basis).

The first bark beetle control work to be undertaken in the Arrowhead-Crestline infestation area was done by the Arrowhead Lake Company during the winter of 1921-22. This work was initiated after the western pine beetle killed a group of large ponderosa pine on the north shore of the lake. The Arrowhead Lake Company covered their own and adjacent holdings, and during the course of the winter, treated 64 infested trees on 8,000 acres. While this work resulted in a reduction in beetle damage the following year, the benefits derived were short lived, and by 1925, tree loss had again become a serious problem. By this time, public interest had been aroused and an eradication district was set up under the pine beetle control law of the State of California. This district functioned for three years. During this time, pine beetle populations were reduced to a low endemic level. As a result, the problem lost public attention and the State eradication district was allowed to lapse.

For a number of years private land owners carried on some work locally in the more intensively used sites, but no concentrated effort was made until 1933-34, when an eradication project was undertaken on both federal and private land through the CCC program.

Further work was carried out at intervals both by private land owners and by the U. S. Forest Service up to the season of 1938-39. However, these efforts were very sporadic and localized to a considerable extent.

During the construction of an artificial lake (Lake Gregory) in the Crestline area in the spring of 1937, a large mass of pine slash was piled in the construction area and left until conditions were favorable for burning in the winter. Large pine engraver beetle populations built up in this material and started attacking standing trees in the vicinity during the fall. The western pine beetle proceeded to build up in the damaged trees during the following summer. This outbreak went unchecked during the season of 1938-39 and had reached alarming proportions by the summer of 1939. Private organizations, individuals and the U. S. Forest Service took action to initiate a comprehensive control campaign. As a result of this action, the Zone Five Flood Control Board authorized the use of district funds for control work on private lands. Since that time, annual cooperative control projects have been carried on in the area.

The control efforts of the 1939-40 season resulted in a sharp decrease in the infestation, and the epidemic raging in the Crestline area was reduced to endemic proportions. Fortunately, it was possible, through the annual maintenance control program alone, to hold beetle losses in the area to a low endemic level from 1941 to 1947. Unfortunately, the potentialities of the infestation were not fully realized and control efforts became geared to a minimum maintenance control program. Between 1947 and 1949, the infestation started to increase in size. This increase occurred so gradually that it did not provoke the attention it deserved. During the 1949-50 control season, it was not possible to complete the winter control project with the funds available. Following this incomplete project, the relatively large residual beetle population left in the area pyramided rapidly with each successive generation, and losses soared to, what was up to that time, an all-time high. The private land owners, the State Division of Forestry, and the U. S. Forest Service, justly alarmed, took action to step up the maintenance control program to meet this infestation increase, and requested entomological assistance on the problem. In the fall of 1950, the Forest Insect Laboratory at Berkeley assigned A. D. Moore to San Bernardino to give technical assistance on this and other projects in southern California.

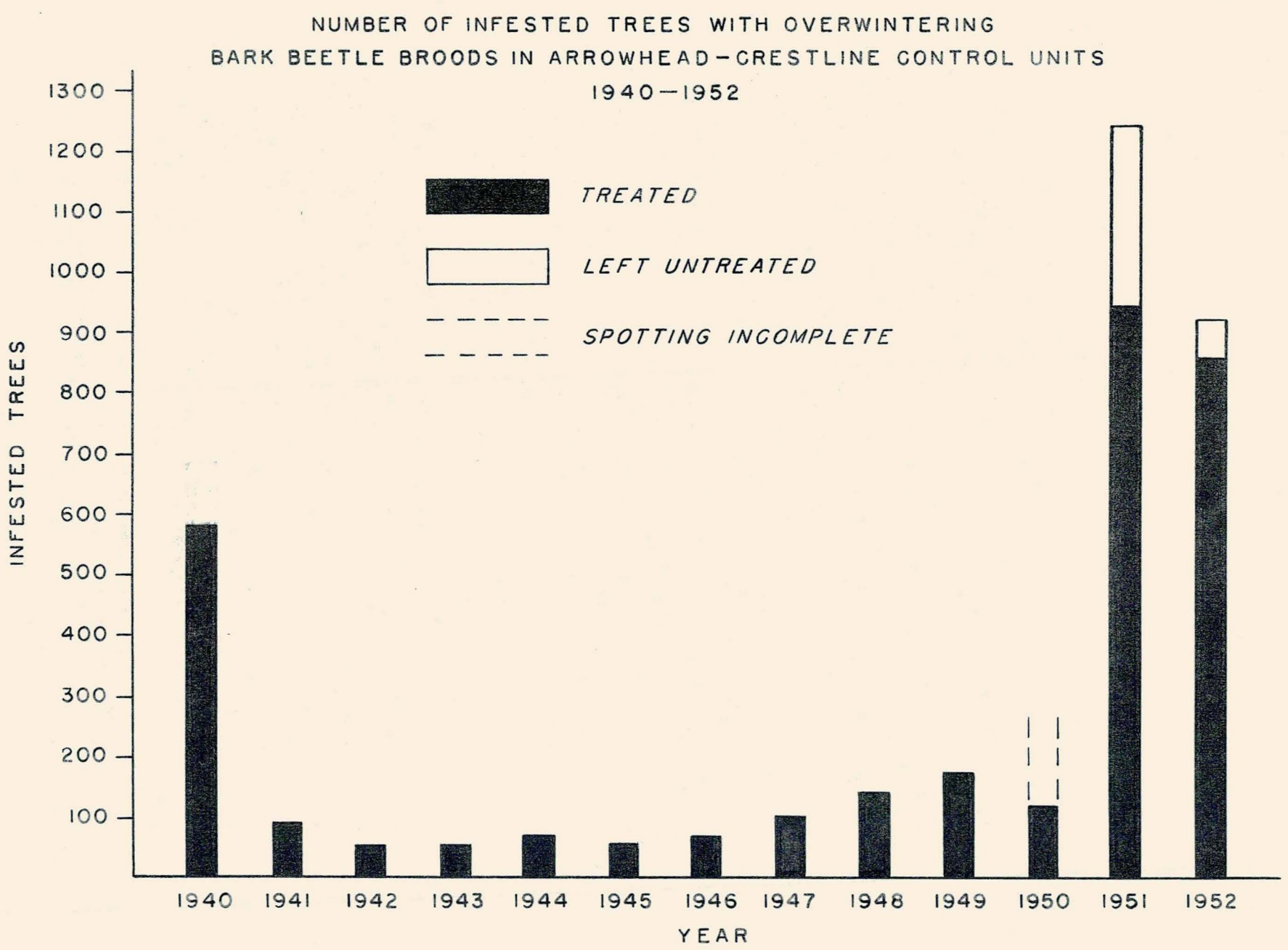
The Zone Five Flood Control District and the State Division of Forestry each appropriated $5,000 for control on private land and the federal government set up $2,200 to treat National Forest lands involved.

There were two main infestation centers in the epidemic that flared up in 1949, one in the Crestline recreational area and one in the Lake Arrowhead recreational area. While beetle losses increased throughout the infestation area during this period, the greatest increase and the heaviest losses occurred in the most highly developed and most heavily used portions of these two areas.

The objectives of the 1949-50 beetle control project were primarily to reduce losses in these two infestation centers and to prevent further increases in loss in all other developed areas.

NUMBER TREES TREATED IN THE ARROWHEAD - CRESTLINE AREA
1940 - 1952
AND COST OF TREATMENT

YEAR (fiscal)	FEDERAL LAND				PRIVATE LAND				TOTAL			
	Number Trees Treated	Average DBH (Inches)	Total Cost	Cost Per Tree	Number Trees Treated	Average DBH (Inches)	Total Cost	Cost Per Tree	Number Trees Treated	Average DBH (Inches)	Total Cost	Cost Per Tree
1940	218	27	$2,747.75	$10.99	352	21	$2,672.73	$ 7.59	570	23	$5,420.48	$9.51
1941	19	23	115.81	6.10	43	19	319.06	7.42	62	20	434.87	7.01
1942	12	26	92.69	7.72	20	22	167.37	8.37	32	23	260.06	8.13
1943	15	24	198.47	13.23	13	23	112.87	8.68	28	23	311.34	11.12
1944	16	20	191.19	11.95	25	14	141.72	5.67	41	16	332.91	8.12
1945	18	26	278.10	15.45	17	16	162.60	9.57	35	21	440.70	12.59
1946	14	25	249.76	17.84	32	16	260.72	8.15	46	19	510.48	11.10
1947	19	19	194.93	10.26	80	13	559.45	6.99	99	14	754.38	7.62
1948	17	22	350.00	20.59	104	16	900.00	8.65	121	17	1,250.00	10.33
1949	56	16	540.11	9.64	98	18	798.57	8.15	154	17	1,338.68	8.69
1950	28	22	496.79	17.44	82	17	999.86	12.19	110	18	1,496.65	13.60
1951	109	18	2,107.48	20.16	854	14	9,891.08	11.58	963	14	12,088.56	12.55
1952	197	19	5,234.97	26.57	644	19	10,284.30	15.98	841	19	15,519.27	18.45
TOTAL	738	22	12,888.05	17.46	2,364	17	27,270.33	11.54	3,102	18	40,158.38	12.94


NUMBER OF INFESTED TREES WITH OVERWINTERING
BARK BEETLE BROODS IN ARROWHEAD-CRESTLINE CONTROL UNITS
1940—1952
TREATED
LEFT UNTREATED
SPOTTING INCOMPLETE
INFESTED TREES
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
1940
1941
1942
1943
1944
1945
1946
1947
1948
1949
1950
1951
1952
YEAR

Due to an unusually warm winter period, beetle activity did not cease as early as usual and the infestation continued to increase after control work was started. As a result, the $12,200 set up for control did not effect complete treatment of all infested trees spotted. Also, it was necessary to leave some trees on private lots in the Arrowhead unit where agreements could not be obtained from the owners involved. Due to the difficulties encountered in obtaining agreements and to the fact that the treating was completed first in the Crestline unit, most of the trees that were left untreated were in the Arrowhead unit (see attached map).

At the close of the control season, the following factors indicated that heavy beetle losses could again be expected during the 1951-52 season: (1) as it had not been possible to complete the 1950-51 project, a relatively large first summer generation of beetles was expected, and (2) large groups of Ips-damaged trees were prevalent in the Lake Arrowhead area and concentrations of western pine beetle broods were expected to build up rapidly in these trees. All indications were that the summer generations would increase in size very rapidly and culminate in a winter generation comparable in size to that encountered the previous season. Therefore, plans were made for continuing the stepped-up maintenance control program through the 1951-1952 season.

1951 - 1952 Control Project

The annual financial and budget planning meeting of the Zone Five Flood Control District was held on May 1, 1951. Representatives of the U. S. Forest Service, State Division of Forestry, and the U. S. Bureau of Entomology and Plant Quarantine attended this meeting. At the time, it was estimated that $15,000 would be needed to continue the stepped-up maintenance control program through the 1951-52 season. The committee approved a motion to appropriate $5,000 of Zone Five tax funds for this work and requested matching funds from the State Division of Forestry and the federal government.

During the period of October 15-17, 1951, two 160 acre sample plots were surveyed, one in the Lake Arrowhead area and the other at Crestline (see attached map). On October 25, 1951, the Bureau of Entomology and Plant Quarantine made a reconnaissance survey of the infestation, using the sample plot data as a guide, to determine the probable size of the overwintering population and control needs. The survey was made while the beetles were in flight and it was difficult to estimate control needs for the coming season. However, the trend in losses indicated that the infestation would not be any higher than it was the previous season, and that $15,000 would be enough to complete the project.

On October 26, Messrs. F. P. Keen and A. D. Moore of the Bureau of Entomology and Plant Quarantine met with Mr. C. J. Kirkpatrick, Chairman of the Zone Five Insect Control Committee; Mr. W. J. Puhn, Assistant Supervisor on the San Bernardino National Forest and Messrs. J. K. Mace and P. Sischo of the California State Division of Forestry. This meeting was held for the purpose

of discussing a three-way cooperative agreement for financing the 1951-1952 project whereby one-third of the project would be financed with forest pest control funds, one-third by the State Division of Forestry, and one-third with private funds. During the course of the meeting, Mr. Mace pointed out that if the existing agreement between the State Division of Forestry and the Zone Five Flood Control District was changed at that time it probably would not be possible for the State to process the new agreement in time to provide the funds needed. Therefore, it was decided that work on private lands would be financed with State and private funds and forest pest control funds would be used on federal lands only. This actually did not alter the distribution of costs, as approximately one-third of the cost of the project was incurred on federal land. It did, however, result in an over-all increase in the total cost of the project due to the extra work involved in administering the work on private lands and on federal lands separately.

By the fall of 1951, it was apparent that losses in the Crestline area had been substantially reduced through the control efforts expended the previous season. As expected, losses in the Arrowhead unit remained heavy. It was also apparent that in undeveloped areas, where no control work had been undertaken the previous year, there had been an appreciable increase in the intensity of the infestation. In view of the high level of loss in the developed areas, however, it was deemed undesirable to undertake an extensive project which would include all of the infestation area at the expense of an intensive project in the developed areas where the intensity of loss was of utmost concern. Therefore, on November 16, Mr. G. P. Lang, District Ranger at Arrowhead, prepared a map showing all of the high priority areas in the infestation zone that should be given the highest degree of protection from insect damage. Within the areas outlined, individual trees are of very high value and the over-all objective of control is to hold beetle losses to an absolute irreducible minimum. A secondary boundary was then plotted around areas where the primary concern is preservation of the forest stand as a whole rather than protection from individual tree loss. These areas were considered to be of second priority in the insect protection program.

A field check was made during the last of November, after the winter generation trees started to show up, to determine the extent and distribution of the infestation in and around each of the high priority areas. Control boundaries were then laid out around each area so as to afford the desired protection (see attached map). At the time the field check was made, it was found that Jeffrey pine beetle losses were at a low endemic level, so no control was recommended in areas of pure Jeffrey pine stands, east and north of Arrow Bear Lake.

Topographic features and the brushline were utilized whenever possible in laying out control boundaries. Where there was no suitable natural boundary within one to two miles, the control work was arbitrarily extended one mile beyond the area to be protected.

Four control units, totaling 15,445 acres in area, were designated for treatment during the 1951-52 season. During the winter control project, a total of 929 trees (200 on federal land and 729 on private land) was spotted in these four units. Of these, 841 were treated (197 on federal land and 644 on private land). Of the trees spotted on private land, 85 were on lots where private land owner agreements could not be obtained for their removal; therefore, they were left untreated. In addition, three trees on federal land were left untreated, as a pretreatment examination showed that most of the beetles had emerged. Unit breakdown of the acreage and number of trees treated is given in the attached table.

During March, 1952, heavy snow and ice storms broke the tops from a large number of trees along the crest of the San Bernardino Mountain Range. As a result of this damage, ideal conditions were created for a buildup of pine engraver beetles in the Arrowhead-Crestline infestation area. As the situation offered a very definite threat to the control program, a cooperative control project was undertaken in the spring to prevent an epidemic from starting in the damaged material 1/. Appraisal surveys made in the fall of 1952 showed a reduction of beetle damage in standing trees in the area, indicating that the operation not only prevented an epidemic from this damaged material, but that the population was probably reduced through treatment of the infested material.

During the summer of 1952, a tremendous western pine beetle buildup occurred in fire scorched trees in the one-year old Little Bear Burn on the northeast shore of Lake Arrowhead. An examination of this Burn showed that practically 100 percent of the trees that were fire scorched, but not defoliated, were infested. An attempt was made to salvage this infested material and to destroy the infesting broods before they could emerge and attack trees in the surrounding green stand. The salvage was only partially completed, however, and by the fall of 1952, very heavy western pine beetle populations had built up in and around the Burn.

A reconnaissance survey in the summer of 1952 showed that the western pine beetle infestation in untreated areas outside the 1951-52 control boundary had increased to the point of jeopardizing the control program in the more heavily used areas. An aerial survey was made to determine the distribution of the infestation and the control boundaries were expanded to include all areas of heavy infestation adjacent to the 1951-52 control boundaries. The new control boundary was then used as a guide in planning for the 1952-53 control season. 2/

1/ Moore, A. D. 1952. An appraisal survey of the Ips engraver beetles in snow-damaged pines, Arrowhead infestation area, San Bernardino National Forest, California. Unpublished Station Report. Forest Insect Laboratory, Berkeley, California.

2/ To be covered in a separate report following completion of the 1952-1953 control project.

UNIT BREAKDOWN OF AREA AND NUMBER OF TREES TREATED IN THE ARROWHEAD-CRESTLINE INFESTATION AREA, SEASON OF 1951 - 1952

UNIT	AREA			% of Infest. Area	TREES TREATED	
	Private (acres)	Federal (acres)	Total (acres)		Number	Percent of Total
Cedar Springs	360	25	385	2	13	2
Crestline	3,280	1,800	5,080	33	94	11
Arrowhead	5,000	2,640	7,640	50	675	80
Running Springs	1,880	460	2,340	15	59	7
TOTAL	10,520	4,925	15,445	100	841	100

DISCUSSION

It is undoubtedly more difficult to administer control operations in the Arrowhead-Crestline infestation area than in any other area of its size in the country. Complications arise from the complex ownership pattern involved and the very nature of the extremely heavy recreational use given the area. There is little question that the high values at stake in this recreational forest warrant a correspondingly high degree of protection from insect damage. However, how this protection can best be afforded is not as obvious. Nowhere are forest stands subjected to as many disturbances by man as in this area. Land-managing agencies and individual owners concerned are faced with a set of conditions that have never existed before in the history of forest stands and a situation that undoubtedly will become more acute with increasing use. As knowledge gained from forest areas which experience less intensive use does not adequately cover this almost semi-artificial forest habitat, it is practically impossible to ascertain the potentialities of insect infestations (especially bark beetle) in this area. Similarly, control practices that prove entirely satisfactory in less intensively used areas cannot be relied on for the type of protection demanded by the concentrated values dependent on the forests in this area. Due to the above considerations, it has not been possible in the past to exercise any great degree of foresight in attacking the problems that arose. However, it is now possible, through hindsight, to make some rather definite recommendations as to what approaches should be taken in the future if insect damage is to be maintained at a level commensurate to the values at stake.

Available infestation records indicate that direct control efforts expended did, in general, effectively reduce beetle losses, and that the reduction in losses was undoubtedly the maximum attainable by the type of projects that were necessarily undertaken (e.g. up until the advent of toxic sprays it was impossible to conduct summer operations due to the lack of a method of control that did not employ the use of fire). This work undoubtedly saved a tremendous number of valuable trees and it is fortunate indeed that such action was taken. There is little question that the present annual maintenance control program should be continued; however, it is apparent from past experience that this work will not fully effect the degree of protection desired unless it is supplemented by other measures.

Recommended Considerations

Following are some recommendations for improving the protection now being provided through annual maintenance control. It is not the purpose of this discussion to present the mechanics of carrying out the proposals. Development of the details of a sound cooperative control program, determination of the responsibilities of each cooperator and efficient execution of each phase can only be accomplished through the cooperative efforts of representatives of the land-managing agencies, private owners, and other interested parties involved. However, some of the difficulties involved and limitations of our present knowledge are mentioned for consideration.

1. Formation of a work committee to establish objectives in the protection program and to decide on control policies and action.

Two major forest land-managing agencies, the U. S. Forest Service and the State Division of Forestry and a tremendous number of private land owners have a very definite interest in the protection program in this area. In view of the complexities involved, any major change in insect protection will involve a number of decisions that can best be made by these interested parties. It is recommended that a work committee, composed of representatives of interested groups should be formed to expedite the development of a sound protection program and to make on-the-spot decisions as problems arise in this program.

One of the first tasks that should be undertaken by this committee is the establishment of clear-cut objectives in the over-all protection program. There is a wide variation in the type of use and values at stake in various portions of the Arrowhead infestation area. It would not be economically feasible or wholly desirable to attempt to afford all of the area the same high degree of protection demanded in the most highly developed localities. The type of protection to be given various portions of the area, after consideration of both the economic and entomological aspects, can best be decided by the land-managing agencies and owners concerned.

2. Provision for constant surveillance of insect conditions within the infestation area.

Insect populations are continually fluctuating. It would be useless to hope that any type of control program would be effective in maintaining static conditions.

Due to continual disturbances by man and the great importance of relatively low levels of infestation in the Arrowhead area, the status of infestations can be expected to change rapidly and to assume major importance in a relatively short period of time. It is especially important that the status of an infestation is known at all times and any fluctuation detected promptly so that appropriate action can be taken at a time when it will do the most good.

3. Initiation of a more intensive and more flexible direct control program than that being followed at present.

One of the major drawbacks to the present maintenance control program is that the work is directed against the overwintering bark beetle broods only. Residual populations left in the area build up rapidly in the summer months and a large number of trees are killed before work is resumed the following winter. A continuous control program directed against all generations would avoid this summer buildup, thus reducing tree loss and the size of the winter project. However, while continuous maintenance control would be highly desirable and is probably the only type of direct control that would be effective in substantially reducing losses, there are certain difficulties that must be overcome before such a program can be undertaken in the Arrowhead area. The major obstacles to such a program are the large size of the area

and the complex, mixed ownership involved. Before summer control could be initiated, it would be necessary to develop a system of spotting that would facilitate coverage of the entire area in a relatively short period of time, and to discontinue the present system of obtaining written agreements from the landowners before removal of infested trees on private land. Obtaining agreements from private land owners is very time consuming and, in most cases, could not be accomplished in the summer months within the period the beetles remain in the trees. The first prerequisite could probably be filled satisfactorily by some form of topographic spotting of fades supplemented by private land owner reports of infested trees. However, treating infested trees on private land without first obtaining land owner permission presents a more difficult problem. Attached is a copy of the agreement employed to obtain private land owner consent for removal of infested trees on private land. This agreement, when signed by the owners of a parcel or piece of land, is good as long as the property does not change hands. However, there is an average annual turn-over in property of about 10 percent. This turn-over plus the herculean task of obtaining initial agreements from some 8,000 current owners precludes the possibility of accruing agreements from all land owners in advance of the control season and conducting operations on the basis of these agreements.

There is some question that the U. S. Forest Service would be willing to treat on any private land without some written agreement with the land owners, as they then would be liable for any accidental damage to private property resulting from the treating operation. It is very probable that everyone concerned would be agreeable to abandoning the present system of obtaining agreements if the infested trees could be treated standing. This may be possible in the future by applying residual sprays with high-powered mist equipment. However, it would not be possible with the penetrating type sprays now employed.

In view of the above, and other considerations (e.g. obtaining competent overhead in the summer months), the possibility of initiating continuous control in this area in the immediate future may be somewhat remote. However, the problem should be given due consideration and every attempt made to initiate such a program.

Another major drawback to the present control program is that it is too rigid to meet unexpected upward fluctuations in insect populations. <u>There is no such condition as a normal infestation level in this area</u>. One of the pitfalls that must be guarded against is that the control program does not, at any time, become geared to a certain level. To overcome this, provision should be made for stepping up the program at any time an unexpected upward fluctuation in infestation occurs (especially if a continuous maintenance control program is initiated).

4. <u>An intense and continuous public education program</u>.

The greatest threats to any direct control program in the Arrowhead-Crestline area are created by man. Therefore, one of the most important supplements to the direct control program is public education, to discourage practices that create conditions favorable for rapid buildup of insect populations.

Preventative control of pine engraver beetles in the area is primarily a public education problem. This insect does not lend itself to direct control, however, conditions that lead to outbreaks are generally preventable.

Western pine beetle infestations in this area are closely correlated with engraver beetle infestations. Past records indicate that the greatest benefits are derived from direct control of the western pine beetle when there is a relatively low incidence of engraver beetle damage in the stand. Conversely, direct control has not affected a substantial reduction in any western pine beetle infestation where there has been a high incidence of engraver beetle damage in the stand. Therefore, it is especially important that every effort possible is expended to prevent engraver beetle damage if the desired results are to be realized from direct control of the western pine beetle.

5. Abatement of hazards created by fire or natural forces.

Whenever potential insect breeding grounds have been created by extensive fire, wind, snow, or ice damage, appropriate action should be taken to avoid any insect buildup in the material. Treatment or salvage of concentrations of material of this type not only results in a saving in later control costs, but also saves valuable trees that would be killed by the beetles produced.

6. Indirect control through silvicultural measures.

In general, the Arrowhead infestation is in vigorous second-growth stands and it would not be possible to affect a high degree of control through silvicultural practices. However, it would seem advisable to supplement direct control through sanitation cuttings where applicable.

Mature and overmature, high-risk trees are scattered throughout the area. While these trees constitute a very small proportion of the infested trees within the more heavily used areas, they assume a more important role on acreage adjacent to the high value areas. Their removal on acreage adjacent to high priority areas should result in a decrease in the number of re-infestations, thus increasing the effectiveness of the direct control program.

7. Research

Our present knowledge in some fields is too limited to enable us to cope with some of the problems that arise in recreational forests. Therefore, it has been necessary, in some cases, to adopt a "do nothing" policy where positive action definitely should be taken. During the last three years, every effort has been made to correct this situation. During this time, some major advancements have been made. Among these were: the development of a method of control that does not employ fire (penetrating oil sprays); determination of the rate of development, generations, and emergence periods of western pine beetle broods during the summer months; and initiation of a continuous maintenance control program in an isolated, federally owned area on a trial basis. As a result of this work, it is now possible to recommend continuous control where it has been necessary in the past to limit operations to the winter season. In addition to the advancements that have been made, there is still a great deal to be accomplished.

The Forest Insect Laboratory at Berkeley is now embarking on a research program to develop formulations and treating techniques for preventing bark beetle attacks in valuable recreational areas with toxic sprays. Realization of the end objectives of this program would provide an ideal solution to many of the problems encountered in the protection of recreational areas. However, there are a large number of details that must be worked out through basic research before any field trials can be conducted, and it is doubtful that much can be gained from this work for several years.

In addition to the work that has already been undertaken, there is an urgent need for much additional investigative work to fill in some serious gaps in our knowledge. The need for much more emphasis on research cannot be stressed too strongly. The present inactivity on some problems of prime importance cannot be tolerated indefinitely. However, before any action can be taken, it will be necessary to strengthen our inadequate knowledge of these problems.

Some major lines of research that should receive attention are:

1. Studies of the bark beetle infestation complex to determine the relative importance of various factors responsible for sudden outbreaks.

2. Direct control of the white fir engraver beetle.

3. Biological control of the black pine leaf scale in the Crestline area.

4. Sampling methods for determining the status of infestations of bark beetles, the black pine leaf scale, and the fruit tree leaf roller and to aid in predicting infestation trends.

5. Control of the California flatheaded borer.

S.B. 316
Rev. 10/3/50

CONSENT TO REMOVAL OF TREES INFESTED WITH PINE BEETLE

I, the undersigned _____
(Owner, agent, contract purchaser, mortgagee, as the case may be)
_____, of the piece or parcel of land located in the San Bernardino National Forest within the County of San Bernardino, State of California, and described hereinafter as follows, to wit:

in consideration of work to be performed, without charge to the undersigned and stated herein, do hereby give my full consent and permission to the United States Department of Agriculture, Forest Service, State of California, and the San Bernardino County Flood Control District, their agents and employees, to enter upon the described piece or parcel of land and to remove and destroy any or all trees classified as timber or forest trees, found and declared to be infested with the pest known as "Pine Beetle," by the Department of Agriculture of the United States of America, all trees so invested and falling within this agreement having first properly having been marked on the piece of land.

I affirm there are not any encumbrances, as mortgages, liens or contracts or agreements, prohibiting the removal of any timber or forest trees found infested with pine beetles.

I understand that Pine Beetle infestations are harmful, detrimental and injurious to timber and forest growth and that timber and forest growths infested thereby are declared by public statutes of California (Forest Insect Control Act; Sta. 1923, Ch. 82, as amended) to be a public nuisance.

I consent to the right of ingress and egress to and from the above described piece or parcel of land by the United States Department of Agriculture, Forest Service, State of California, and the San Bernardino County Flood Control District, their agents and employees at any and all times during the performance of the work.

I understand that the Forest Service does not assume any liability for damages or injuries (except to its own employees), to persons or property resulting from their work in removing and/or destroying insect infested trees. I further understand the Forest Service will not attempt to remove or destroy any insect infested trees which in its judgment is considered dangerous to remove or destroy.

Witness, my hand the _____ day of _____ 195____

_____
(Owner)

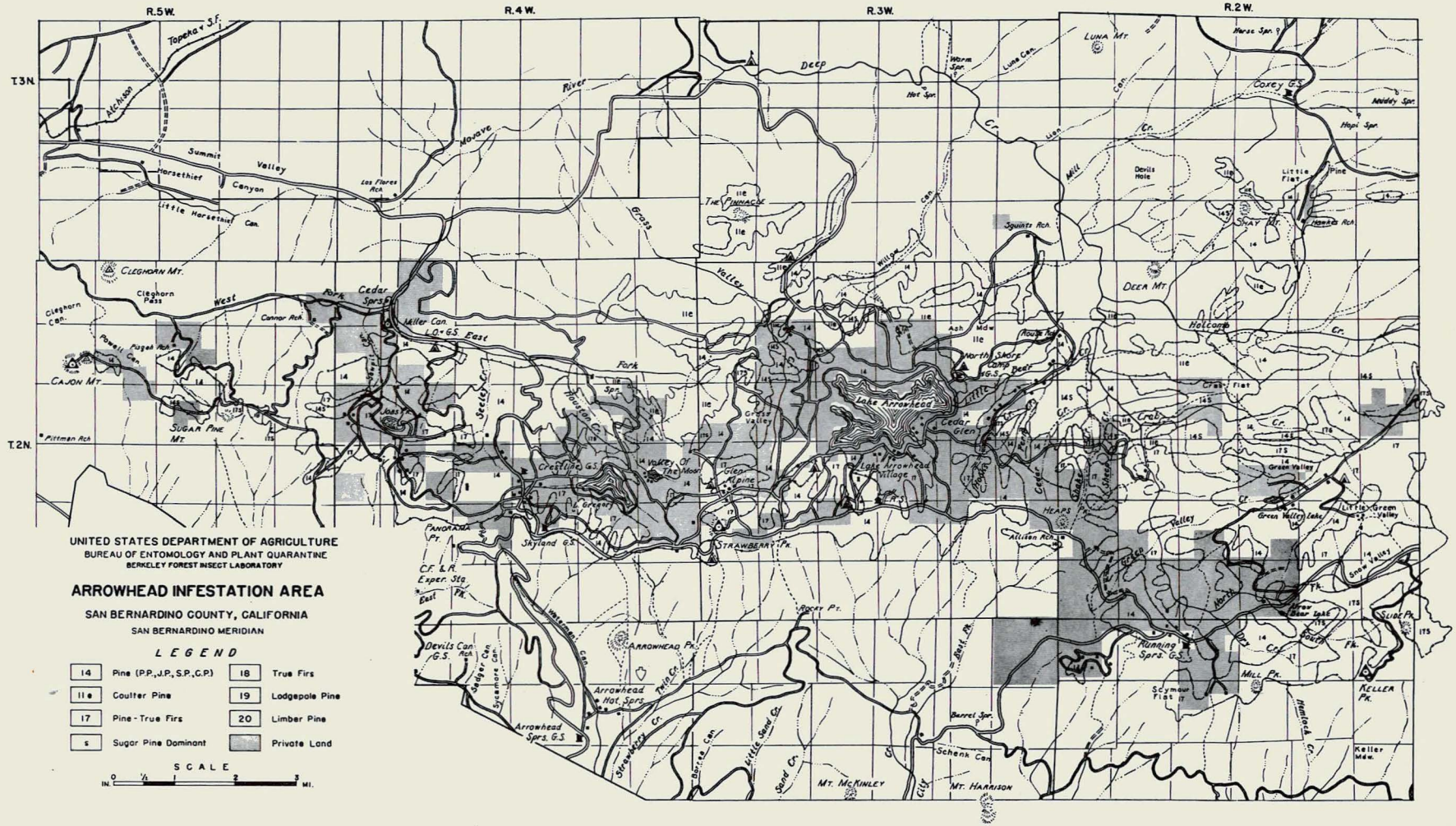
_____
(Agent)

WITNESS:

_____
(Contract Purchaser)

_____

_____
(Mortgagee)



UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
BERKELEY FOREST INSECT LABORATORY

ARROWHEAD INFESTATION AREA

SAN BERNARDINO COUNTY, CALIFORNIA

SAN BERNARDINO MERIDIAN

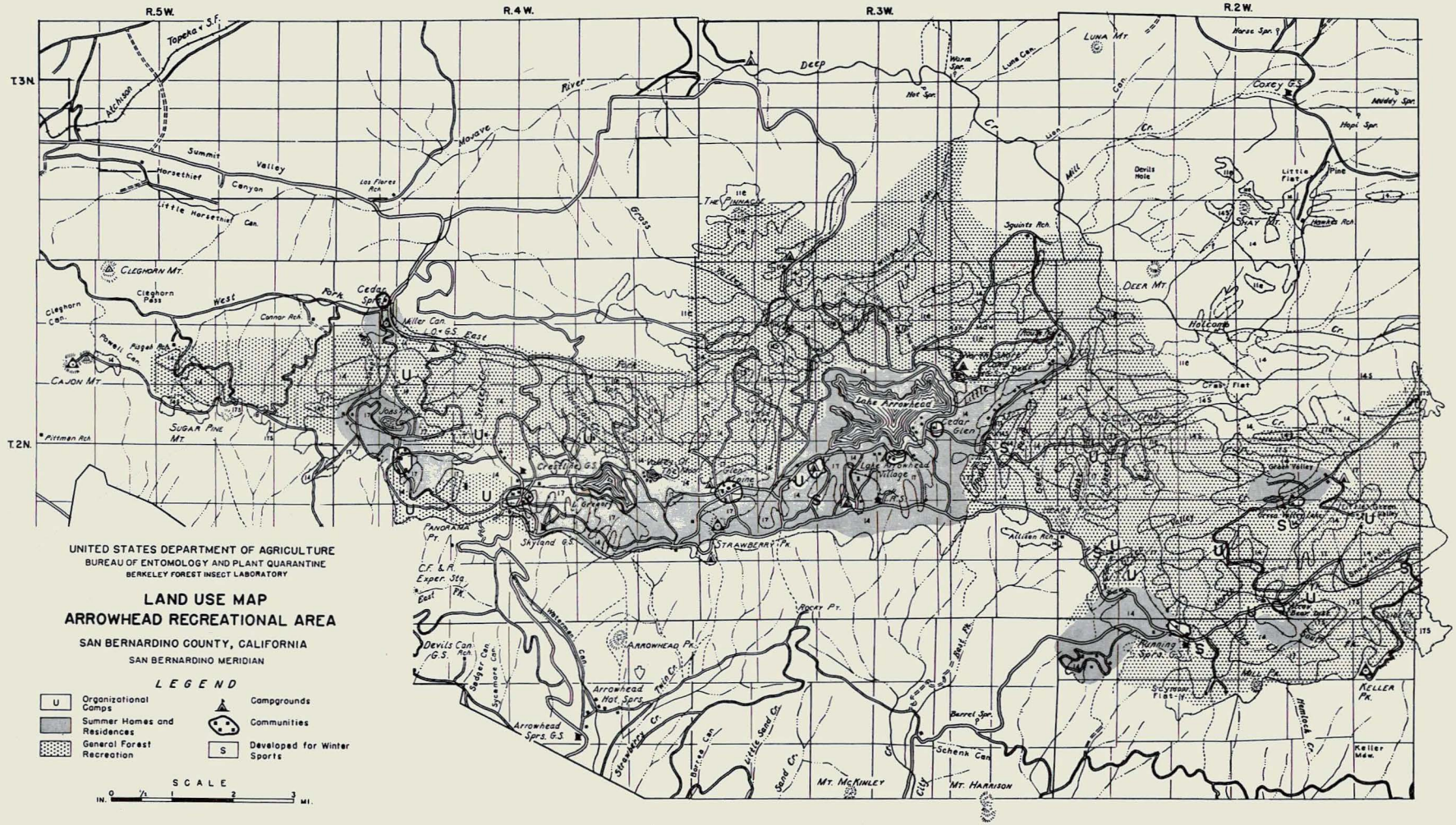
LEGEND

14	Pine (P.P., J.P., S.P., C.P.)	18	True Firs
11e	Coulter Pine	19	Lodgepole Pine
17	Pine - True Firs	20	Limber Pine
s	Sugar Pine Dominant		Private Land

SCALE

IN. 0 ½ 1 2 3 MI.

4/20/51 F.E.F.



UNITED STATES DEPARTMENT OF AGRICULTURE
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BERKELEY FOREST INSECT LABORATORY

LAND USE MAP
ARROWHEAD RECREATIONAL AREA

SAN BERNARDINO COUNTY, CALIFORNIA

SAN BERNARDINO MERIDIAN

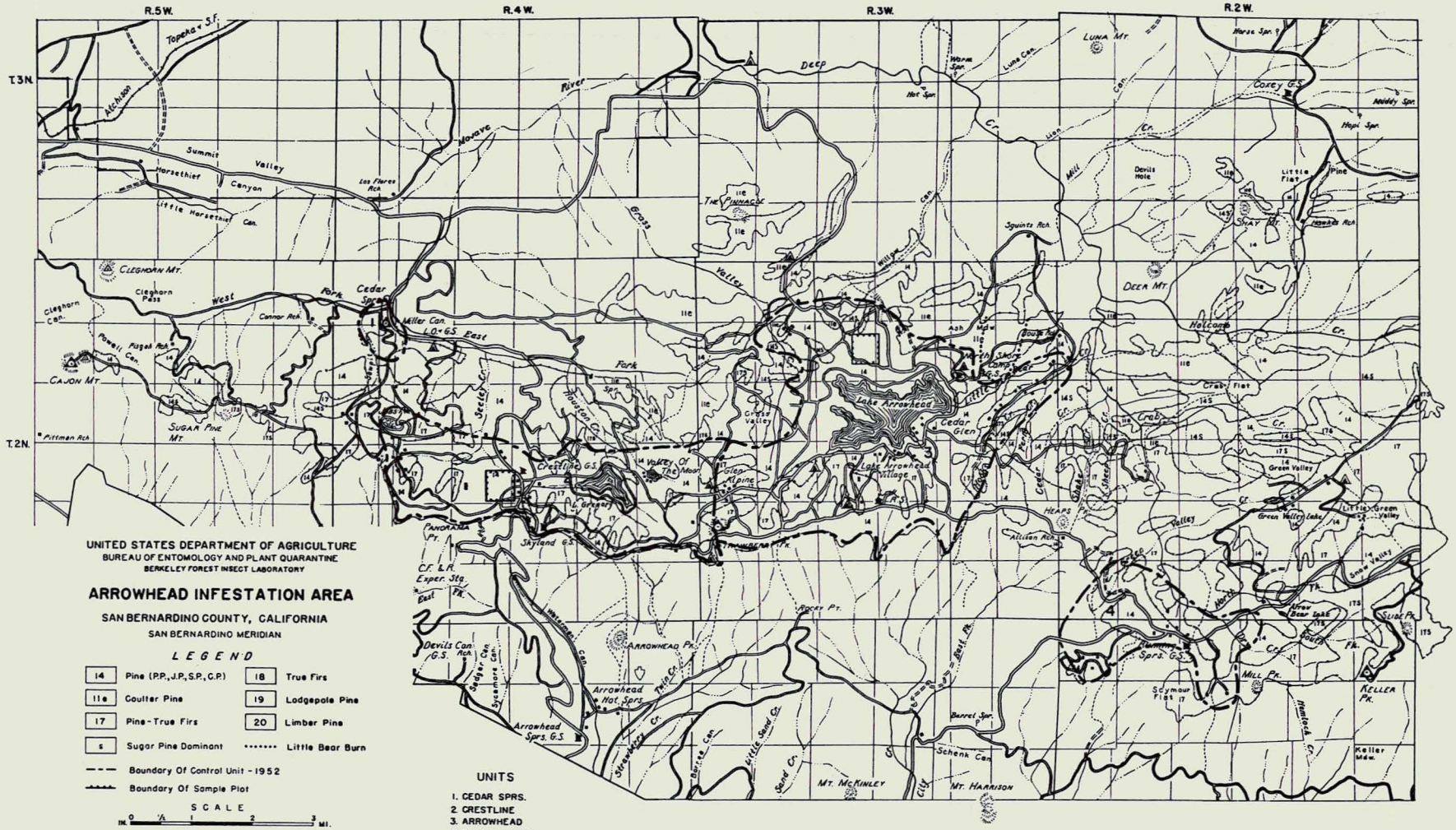
LEGEND

- U — Organizational Camps
- Summer Homes and Residences
- General Forest Recreation
- Campgrounds
- Communities
- S — Developed for Winter Sports

SCALE

IN. 0 1/2 1 2 3 MI.

4/20/51 F.E.F.



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ARROWHEAD INFESTATION AREA

SAN BERNARDINO COUNTY, CALIFORNIA
SAN BERNARDINO MERIDIAN

LEGEND

14	Pine (P.P., J.P., S.P., C.P.)	18	True Firs
11e	Coulter Pine	19	Lodgepole Pine
17	Pine - True Firs	20	Limber Pine
s	Sugar Pine Dominant	·····	Little Bear Burn
– – –	Boundary Of Control Unit - 1952		
▲▲▲▲	Boundary Of Sample Plot		

SCALE
IN. 0 ½ 1 2 3 MI.

UNITS

1. CEDAR SPRS.
2. CRESTLINE
3. ARROWHEAD
4. RUNNING SPRS.

4/26/51 F.E.F.